Multi-Phase Equations of State for Metals over Wide Range of Temperatures and Pressures

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The analysis of the thermodynamic properties of matter over a wide region of the phase diagram is of fundamental as well as practical interest. The numerical solution of many problems in high-energy-density physics calls for equations of state for structural materials over the range from normal conditions to extremely high values of temperatures and pressures. In this report we present the results of constructing wide-range semiempirical equations of state for 30 metals which allow for elastic interaction in the crystal lattice, anharmonicity of the thermal vibrations of nuclei, and the contribution of thermal excitation of the electron components, as well as for melting, evaporation, and ionization effects. Within the high-temperature limit, the equations of state display asymptotic behavior for an ideal, fully ionized plasma consisting of electrons and nuclei. The most essential static and dynamic experiments for constructing an equation of state are described for each of the metals investigated; and calculation results are compared with experimental data. Also presented are new results obtained by calculations for regions for which no experimental data are presently available and for which theoretical models only yield general estimates. This applies primarily to the position of the high-temperature evaporation curve and of the critical point. Consequently, the results obtained may be used effectively in calculations of the thermodynamic characteristics of metals when solving applied problems.